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DETERMINATION OF YELLOW RUST DISEASE (*Puccinia striiformis* f. sp. *tritici*) RESISTANT OF THE WHEAT LANDRACE COLLECTED FROM ISPARTA AND BURDUR PROVINCES

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Abstract

In this study, we aimed to determine the genetic diversity of wheat genotypes grown in Isparta and Burdur provinces, to protect valuable genotypes as a germplasm source and to take them into breeding programs. In the study, about 104 villages were visited and 72 wheat seed samples were taken from 45 different locations. The resistance of the sampled wheat varieties/populations to yellow rust disease was examined and the following results were obtained; the rate of resistant genotypes (R) was 6% (disease severity 1-2%), the rate of moderate resistant genotypes (MR) was 33% (disease severity 6-20%), the LM rate was 33% (21-40%), the rate of those in the M group was 19% (disease severity 41-60%), and the rate of HM, which has a little less tolerance, was 8% (disease severity 61-80%). Very few of the collected material was found to be resistant (6%) and most of the material was tolerant (85%).
As a result, it can be said that a large part of wheat genotypes grown in Isparta and Burdur provinces are tolerant to the yellow rust disease and a small part is resistant. In particular, we report that a large part of the population defined by local names (88%) is tolerant, and very few of them are resistant (2%).

Key words*: Landrace, stripe rust, wheat.*

INTRODUCTION

Turkey is one of the gene pools of wheat as other many plant species. The richness of wheat varieties determined by the evaluation of genetic materials obtained from sampling trips at different times confirms this (Anonmys, 2012). The cultivated wheat consisted of local varieties with high heterogeneity until the late 1800s (Feldman et al., 1995). However, as a result of breeding studies in order to increase productivity and quality in recent years, the genetic diversity of culture forms has decreased; susceptibility to pests, environmental stress, and different diseases have increased, and generally, the genetic basis of all culture wheat has remained narrow (Feldman, Sears, 1981; Reif et al., 2005; Yeşbek, 2007).

Stripe (yellow) rust disease (*Puccinia striiformis* Westend f. sp. *tritici)* appears in leaf stalk and head of plants, although it is seen as intense at leaves. On the upper surface of leaves, yellow color pustules appear in the form of machine stitch, so it can be called "stripe rust" (Şahin, 2009). Stripe rust is generally observed in wheat in almost all regions in our country and differs according to the sensitivity of varieties, environmental conditions, etiological source, years and regions (Zeybek, Yiğit, 2004). Stripe rust disease seen in high altitude areas, cold climates (2-15^{0}C), northern latitudes reduces the green portion where photosynthesis takes place in plants, thus reducing yield and grain quality and causing loss in rates ranging from 10% to 70% (Temel, 2006), as well as decreasing the quality value since it allows grains to be wrinkled and weak (Furan, Yüce, 2009).

As in the entire country, genetic erosion in wheat is increasing in our region. Local wheat species/varieties that have adapted to the region where it grows in a long time period are of great importance as rich gene sources. Therefore, determining, collecting and protecting material that may be important gene source is important in securing our future.

This study aims to determine the sensitivity of wheat genotypes in Isparta and Burdur provinces, against stripe rust disease. In these regions where a genetic diversity has been determined before, protection of germplasm resources which can be used for different purposes, evaluation them in breeding programs, and investigation of the resistance of sampled materials to yellow rust disease have been targeted.

MATERIALS AND METHODS

The wheat seeds used in this research were obtained from registered varieties and landrace populations cultivated in the regions of Isparta and Burdur provinces and their districts and villages. Seed samples are named by number plate system (Table 2). According to this system, each material is numbered first with the number plate of the province where it was taken, and then the first letter of the name of the district, and then the sample number. In this study, 104 villages were visited to collect wheat samples, then 72 wheat seed samples were taken from 45 different locations [Eğirdir (5), Aksu (9), Keçiborlu (4), Yalvaç (6), Gelendost (6), Yenişarbademli (1), Sütçüler (9), Şarkikaraağaç (6), Burdur Central Villages (7), Bucak (3), Çavdır (1), Çeltikçi (1), Kemer (2), Gönen (2), Altınyayla (4), Gölhisar (5) and Ağlasun (1)].

The seeds of 72 wheat genotypes sampled from different locations were planted in separate plots with sowing machine in autumn 2008. Each plot area was 4.8 m^2 and consisted of 6 rows. Seedling rates were 500 seeds/m^2. The basic pre-sowing fertilization rates for all plots were 30 kg N·ha^{-1} and 40 kg P·ha^{-1}, the rest of 30 kg N·ha^{-1} was applied at the early spring (stem-elongation stage). The collected wheat genotypes were evaluated in terms of yellow rust disease. 10 random plants in each trial plot were picked up and a total of 2 leaves of each plant including the flag leaf and the leaf below were used to estimate the severity of disease (Zadoks, Schein, 1979).

Disease severity was calculated according to the following Tawsend-Heuberger formula by taking the average of 2 leaves from 10 plants (Karman, 1971).

Table 1. Defining the type of infection of yellow rust disease in wheat genotypes

Signs and Symptoms for Infection Types	Codes	Disease index or Infection type	Disease severity (%)
No visible signs or symptoms	0	0	0
Necrotic and/or chlootic flecks; no sporulation	VR	1	< 1
Necrotic and/or chlorotic blotches or stripes; no sporulation	R	2	1-5
Necrotic and/or chlorotic blotches or stripes; trace sporulation	MR	3	6-20
Necrotic and/or chlorotic blotches or stripes; light sporulation	LM	4	21-40
Necrotic and/or chlorotic blotches or stripes; intermediate sporulation	M	5	41-60
Necrotic and/or chlorotic blotches or stripes; moderate sporulation	HM	6	61-80
Necrotic and/or chlorotic blotches or stripes; abundant sporulation	MS	7	81-95
Chlorosis behind sporulating area; abundant sporulation	S	8	96-99
No necrosis or chlorosis; abundant sporulation	VS	9	99

H=High, L=Light, M=Moderate, R=Resistant, S=Susceptible, V=Very

Disease severity (%) = [(Total scale value/Total number of plants) x (Scale value excluding "0") x 100]

According to the disease severity results, 0=0, 1=<1%, 2=1-5%, 3=6-20%, 4=21-40%, 5=41-60%, 6=61-80%, 7=81-95%, 8=96-99%, 9=99% scales were used (Stubbs et al., 1986). Infection type was determined according to the 0-9 scale in disease evaluation (Table 1).

The total rainfall was 514.4 mm during the plant growth period of 2008-2009, and the average temperature was 11.5^oC (Table 3).

Table 3. Important climate data for the experiment year and many years of Isparta

Climate Factor	Year/ Month	Sept	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	July	Mean/Total
Average Temp. °C	2008-2009	18.0	12.8	9.0	3.7	3.4	4.0	5.5	10.9	14.9	21.0	23.6	**11.5**
	Means for many years (1930-2000)	18.4	12.9	7.5	3.5	0.0	2.7	5.6	10.6	15.4	19.7	23.1	**10.9**
Total Precipitatio (mm)	2008-2009	26.2	32.0	60.0	5.4	124.0	68.2	53.6	39.0	61.2	26.8	18.0	**514.4**
	Means for many years (1930-2000)	15.1	36.7	44.7	91.2	79.8	70.9	61.4	52.4	55.1	33.6	13.4.	**554.3**

*Isparta Meteorology Regional Directorate records

RESULTS AND DISCUSSIONS

Collected wheat genotypes were identified with local names and 18 with variety names (Table 2). Stripe rust has been widely seen in the trial area in 2008-2009. Therefore, the evaluation of the sampled material in terms of stripe rust was done. The results are given in Table 2. As for resistance of wheat varieties/populations to stripe rust; resistant genotypes (R) ratio was 6% (with necrotic/chlorotic lines and without spore), moderately resistant (MR) ratio was 33% (disease severity is between 6% and 20%, spore traces are seen besides necrotic/chlorotic lines), LM ratio was 33% (necrotic/chlorotic lines and light sporulation), M ratio was 19% (necrotic/chlorotic lines, a greater proportion of sporulation, disease severity 41-60%), and the ratio HM, slightly less tolerant, was 8% (necrotic/chlorotic lines as well as moderate sporulation, disease severity was 61-80%) (Figure 1). A small part of the sampled material was found to be resistant (6%) and the majority of the material was tolerant (85%).

A genotype named as Hatay-85 were thought to be the Atay-85 variety and it showed the characteristics of Atay-85 in terms of resistance to stripe rust. Again, the material collected under the name of Cumhuriyet was compared with Cumhuriyet-75 type and Cumhuriyet-75 type was described through variety registration as sensitive. The type of Cumhuriyet used in this trial was determined to be tolerant. Other wheat genotypes sampled with variety names showed similarity as defined in the variety registration.

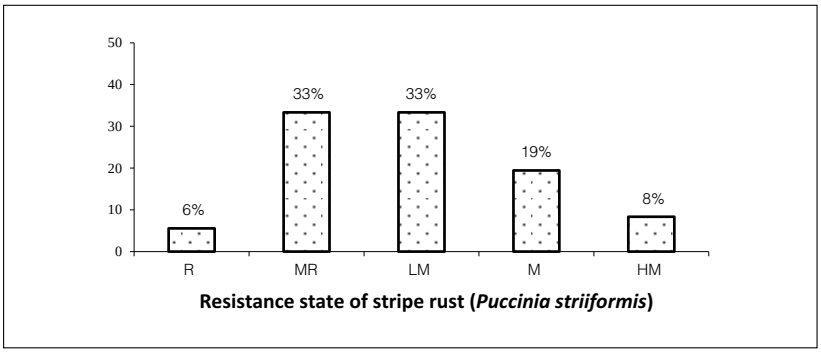

Figure 1. Resistance state of stripe rust (*Puccinia striiformis*) in wheat genotypes

2% of the population identified with local names was found to be in the resistant group (R), 31% in the moderately resistant (MR) group, 35% in the LM group, 22% in the M group and 9% in the less tolerant group (HM). 17% of the samples possessing a variety name were found to be in the resistant group (R), 39% in the moderately resistant (MR) group, 28% in the LM group, 11% in the M group and 6% in the tolerant (HM) group (Figure 2).

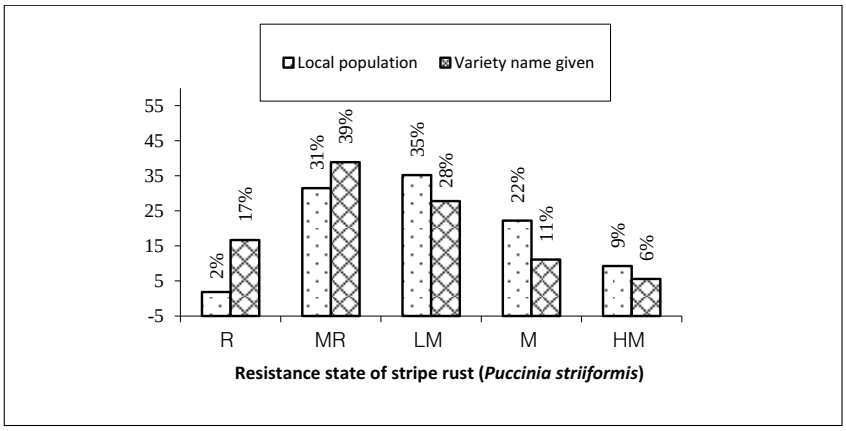

Figure 2. Resistance state of the stripe rust (*Puccinia striiformis*) in collected wheat landrace population and varieties

In the study, disease severity varied for the samples from different places with the same names. Although a local population, defined as Kocabuğday, was generally moderately resistant to yellow rust disease, the severity of the disease varied slightly according to the regions and was coded as LM, HM and M similar situation was detected in other genotypes. This indicates that there may be resistance to different disease strains. Indeed, in a study conducted to determine yellow rust breeds in the USA, 20 wheat samples collected from 20 different states were analyzed, including Clement (Yr9, YrCle), Compair (Yr8, Yr19) and Yr8 and Yr9 isogenic lines. In addition to the previously identified 21 strains, 21 new ones have been identified (Chen et al., 2002). In our country, the most comprehensive study on the determination of yellow rust strains of seedlings was carried out by Ateş and Biçici (2007) in the climate room and cropland conditions. In the study, reaction studies were carried out under natural inoculation conditions, consisting of 137 wheat varieties and lines. According to the results of seedling inoculation of domestic commercial wheat varieties, while the Panda was very resistant to the stripe rust *P. striiformis*; Segatario, white wheat were resistant, and Series 82 was susceptible. In addition, yellow rust assessment was made in natural inoculation conditions of domestic varieties; so, Balatilla, Chils, Amanos, Doğankent, and Yüreğir varieties were found to be resistant (R); Ceyhan 99, Gerek, Dariel varieties (M) were found nearest to susceptible. Wheat varieties which are known to be resistant to rust disease can be susceptible later. In addition, due to long-term cultivation and due to break the resistance by a pathogen, the varieties can be sensitive depending on the climate conditions, environment, and rust strain. Likewise, Mert et al. (2016) detected unexpected stripe rust infections in winter wheat cultivars grown in the Northwest region of our country in 2014 season. Some species known to be resistant (Enola, İzgi 2001) have been reported to be fully susceptible to certain stripe rust races.

In general, a large part of the collected wheat genotypes are tolerant to the stripe rust disease and a small part is resistant. In the study, no sensitive genotypes for stripe rust were determined. Kurt (2013) reported that the Golia, Zenit, Bezostaja and Gerek 79 cultivars were sensitive, while BasriBey 95 and Tahirova 2000 were resistant. Although this literature reported that Gerek 79 and Bezostoja varieties were susceptible, in the present study conducted under Isparta climate conditions, Gerek 79 variety was included in the MR and LM group, and Bezostaja variety in the R, MR and HM group. Bezostaja was registered as resistant and Gerek 79 as tolerant.

Stripe rust is generally observed in wheat in almost all regions in our country and differs according to the sensitivity of varieties to disease, environmental conditions, etiological source, year and region (Zeybek, Yiğit, 2004).

Stripe rust was seen in high altitude areas, cold climates (2-15^{o}C), northern latitudes reduces the green portion where photosynthesis takes place in plants, thus reducing yield and grain quality and causing loss in rates ranging from 10% to 70% (Temel, 2006), as well as decreasing the quality value (Temel, 2006) since it allows grains to be wrinkled and weak (Furan, Yüce, 2009).

Bicici et al. (2000) reported that the number of hot and rainy days during the season may be important for the formation of yellow rust epidemic.

In different climatic conditions of our country, similar studies have been carried out before, investigating on the sensitivity and resistance of wheat varieties. Alp and Sağır (2009) tested 50 hard wheat samples from 11 different local strains for stripe rust. They displayed that 15 of the 50 wheat samples were the stripe rust-resistant, 19 was medium-resistant and 14 were medium-sensitive. In addition, high rust density was found in a group of Aşure local strain (61.68%) and Ruto local strain (0%) was in the resistant group.

Reaction studies of 126 bread wheat varieties in natural inoculation conditions for rust diseases were carried out by Ay (2013) in Adana city. According to the results, it was determined that 49 bread wheat varieties were stripe rust-resistant, 6 bread wheat varieties were medium-resistant to the stripe rust and 2 bread wheat varieties were mild-sensitive. Among these, Ziyabey 98 was found to be stripe rust-resistant, Kaşifbey and Genç 88 varieties were mild-sensitive.

CONCLUSIONS

As a result, in the areas where wheat cultivation is performed, yield loss occurs due to rust diseases when chemical control cannot be done. Therefore, the most important control method of rust diseases is the development and use of resistant varieties. However, due to the continuous emergence of new varieties of rust disease, studies for resistance improvement require continuity. Our country has rich genetic resources of wheat. In this way, the evaluation of gene sources, by scanning, especially for use in the determination and breeding studies of novel varieties will be important for developing and using resistant varieties against rust diseases. We report that most of the local populations (88%) in the present study are resistant, and very few of them are resistant (2%).

Table 2. Evaluation of yellow rust disease (*Puccinia striiformis*) of wheat genotypes

Label No	**The name of collected wheat variety**	**Resistance state of stripe rust (*Puccinia striiformis*)**	**Label No**	**The name of collected wheat variety**	**Resistance state of stripe rust (*Puccinia striiformis*)**	**Label No**	**The name of collected wheat variety**	**Resistance state of stripe rust (*Puccinia striiformis*)**	**Label No**	**The name of collected wheat variety**	**Resistance state of stripe rust (*Puccinia striiformis*)**	**Label No**	**The name of collected wheat variety**	**Resistance state of stripe rust (*Puccinia striiformis*)**
32E01	Kırmızı buğday	MR	32K17	Gerek-79	MR	32YB34	Hatay-85	MR	32Ş75	Bezostaja	MR	15G80	Sarıkılçık	MR
32E02	Çavdar + arı	R	32K18	Kocabuğday	M	32S36	Name unknown	MR	32Ş76	Gerek 79	LM	15M63	Çakmak-79	LM
32E03	Cumhuriyet	R	32K19	Rumeli	MR	32S37	Hatay-85	MR	15M46	Kocabuğday	M	15M67	Kocabuğday	MR
32E04	Ziraat Buğdayı	LM	32Y20	Yerli kırmızı buğday	LM	32S38	Çavdar+arı buğdayı	M	15B47	Aydın	LM	15M68	Kocabuğday	LM
32E05	Ziraat Buğdayı	MR	32Y21	Yerli kırmızı buğday	LM	32S39	Ziraat buğdayı	MR	15B48	Sarı misli (gökala)	LM	15M69	Kocabuğday	M
32A06	Cumhuriyet	LM	32Y22	Ç-1252	LM	32S40	Arıbuğday	MR	15B49	Kocabuğday	MR	15M69-1	Çakmak-79	MR
32A07	Kocabuğday	HM	32Y23	Kırmızı buğday	LM	32S42	Buğday	M	15Ç52	Kaymakam	M	15M70	Kocabuğday	LM
32A08	Kocabuğday	HM	32Y24	Gün-91	MR	32S43	Kızılevi	LM	15ÇE53	Akça	LM	15A71	Morkılçık	MR
32A09	Kocabuğday	HM	32Y27	Gün-91	R	32S44	Çavdar+arı	LM	15K54	Kocabuğday	LM	15A72	Karakılçık	LM
32A10	Kocabuğday	M	32G28	Kızıltan	MR	32S45	Çavdar+arı	M	15K55	Kaymakam	LM	15A73	Hatay-85	MR
32A12	Kocabuğday	M	32G29	Kırmızı buğday	HM	32GÖ56	Kızıltan	M	15A58	Çakmak	LM	15AĞ81	Sarı Buğday	MR
32A13	Kocabuğday	LM	32G30	Ç-1252	M	32Ş64	Hatay-85	MR	15G59	Karakılçık	LM			
32A14	Kocabuğday	HM	32G31	Kırmızı buğday	M	32Ş65	Ankara	MR	15G60	Kocabuğday	LM			
32A15	Kocabuğday	LM	32G32	Düz buğday	M	32Ş66	Konya	MR	15G61	Karakaşık	MR			
32K16	Bezostaja	R	32G33	Name unknown	LM	32Ş74	Hatay-85	MR	15G62	Bezostaja	HM			

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